ART. II.—*Geology of the Valley of the Lower Mitchell River.*

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(With Plates II. to VIII.).

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CONTENTS.

I.—INTRODUCTION.

The previous literature dealing with this portion of the Mitchell River area consists of:—

(1) Notes on the Geology of part of the Mitchell River division of the Gippsland Mining District, by A. W. Howitt, F.G.S.[1]

(2) Continuation of ditto[2].

(3) Notes on the Physical Geography and Geology of North Gippsland, Victoria, by A. W. Howitt, F.G.S.[3]

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1 Geological Survey of Victoria. Reports of Progress, No. ii., 1874.
2 Ibid., No. iv., 1877.
3 Q.J.G.S., vol. xxxv., 1879.

(4) Notes on Miocene Strata at Jemmy's Point, and

(5) Appendix to remarks on "The Older Tertiary Strata at Bairnsdale," by J. Dennant.[1]

(6) The Miocene Strata of the Gippsland Lakes' Area, by Dennant and Clark.[2]

In the last mentioned paper certain ferruginous beds at Boggy Creek and elsewhere on the Mitchell River were briefly referred to, and in a footnote it was stated that from an examination of their fossil contents they have been determined as miocene. A detailed study of the material since gathered from various outcrops on the river bank proves, however, that this statement is only partially correct. For a short distance from Bairnsdale the beds are undoubtedly miocene, but higher up the river the fossil casts in the ironstone represent, as we shall presently see, an older fauna.

These fossiliferous ironstones form a marked feature of the Mitchell River banks, and the main purpose of the present paper is to describe them and refer them to their proper location in the tertiary series. They have been generally alluded to in the past as a deposit of uniform age which it was supposed had filled in an excavated area at the contact of the Bairnsdale limestones and the Avon sandstones. We, however, separate them into two main divisions, one of which is miocene, and a westerly extension of the Jemmy's Point beds, and the other earlier, and contemporaneous with the eocene limestones and shell beds of the river banks.

Another deposit which claims attention is the well known pebble drift or conglomerate. In the bed of the river, on its banks, in road and railway cuttings, it is everywhere prevalent. Its origin and the mode of its distribution will be referred to as the various sections come under review.

II.—Surface Configuration of Area.

Under this heading the leading features of the valley of the Mitchell from Iguana Creek to the mouth of the river are outlined.

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1 Proc. Roy. Soc. Vict., vol. iii., n.s., 1891.

2 Proc. Roy. Soc. Vict., vol. x., n.s., 1898.

The Mitchell River after flowing in a southerly direction through rugged and hilly country consisting of devonian sandstones, shales, and conglomerates turns sharply to the east when it enters the tertiaries and continues in this course until it discharges into Lake King. The watershed on the southern side is comparatively narrow. Moitun Creek, after flowing through devonian rocks, enters the Mitchell as it passes into the tertiaries, and the only other creeks discharging into it on this side are Lucas Creek, which joins it near Perry's Bluff, and Cobbler's Creek, which, after passing through McLeod's morass, junctions with the river near Eagle Point. The watershed line consists of a high sandy ridge which starts from the devonian hills, three or four miles to the south of Moitun Creek and continues in a direction approximately parallel to the course of the river. The height of the ridge is about 400 feet above sea level at its western extremity, and at its termination, at Eagle Point, about 85 feet. The latter is a conspicuous feature of the right bank of the Mitchell below Bairnsdale, which arrests the attention of passengers on the Lakes' Entrance steamers. The section from its summit to the river level, as illustrated in Fig. 2, contains the following strata :—

Gravel, with stones up to 5in. in diameter -	20 feet.
Yellow sand - - - - - - - -	30 ,,
Coarse cemented sand - - - - -	15 ,,
Fine cemented sand and gravel in layers -	15 ,,
Total	80 feet.

The highest ridges consist almost entirely of sand, while, at a lower elevation of from 150 to 200 feet above sea level, this is mostly replaced by a clayey soil, which, in general, is full of small circular depressions a few feet in diameter, locally termed crab holes. In very wet weather these form almost continuous sheets of water, but in summer they open into cracks which extend downwards for a considerable depth, allowing the water to escape.

At an elevation of about 100 feet above sea level, a lower terrace runs parallel to the river, on which is a soil of the same character as that higher up. Near the limestone banks, especially

at Hillside, inverted conical depressions of considerable area occur, as much as from 200 to 300 feet in diameter and from 50 to 60 feet in depth, such as are common in other limestone districts.

The flats on the banks of the Mitchell vary in width from about two miles at the upper end to less than half a mile at Bairnsdale, where they are confined by limestone cliffs. Their fall follows that of the river, and is approximately 100 feet in about 25 miles. The soil on them consists for the most part of a loose, friable, siliceous material of great depth. In the upper portions of the river, where its fall is greater and the flats are wider, the general slope is from the higher, more distant banks towards the stream ; in places where subsidiary channels have formed, the slope is towards them ; in flood times it is by the backing up of water in these that portions of the flats are submerged. In the lower portions of the river, the banks now enclosing the channel are much higher than the flats which, in general, fall away from them, and towards the earlier formed, more elevated banks that bound them, so that during floods the actual margins of the river are the last portions to become submerged. The bed of the channel itself was originally confined between banks which were covered with dense vegetation. Above Lindenow the stream at one time consisted of long stretches of deep water and shallow rapids over loose stones. Below Hillside there was one continuous deep channel to the mouth of the river. The present state of the stream is widely different. The river banks have been denuded of vegetation, and broken down in many places by stock, with the result that the loose, friable soil has disappeared by the acre, and a stony gravel bed, sometimes over a hundred yards across, has been exposed ; the banks also have been left vertical, to wash farther and farther away with every flood. The lighter material is swept over the lower lands and passes into the lakes, while the heavier material is continually creeping down what was once the deep channel of the river, plugging it up solidily as it goes. This action has gone on until it is now possible to ford the river near Bairnsdale, while in the earlier days the Manaro crossing at the Wuk Wuk village settlement, was the point at which the river was fordable. Below Bairnsdale the river is from 200 to

260 feet in width, the depth of the channel varying from 14 to 30 feet. It is subject, when low, to tidal influences, salt water creeping up as far as the Bairnsdale waterworks, or a distance of from 15 to 16 miles from its mouth. The banks from Bairnsdale down slope on the eastern side towards Jones' Bay, one of the Gippsland Lakes, and on the western side towards McLeod's morass. About a mile below the morass, the current sweeps against Eagle Point, the ridge terminating the watershed; from this point it flows through a tongue of land for nearly five miles, the exact distance between a trig. station on Eagle Point, and another at the present terminus of the land being 7366 yards. This strip of land varies in width on either side from 200 to 2000 feet, the average being less than 1000 feet; on one side it slopes to Jones' Bay, and on the other to Eagle Point Bay. After passing the present landmarks forming its mouth, the river flows in a well defined channel in Lake King for 2100 feet, with an average width of 160 feet, and of depth 10 to 12 feet at low water, the banks being about 2 feet below the surface, except after a heavy flood, when they appear above it. The submerged bank extends for about 1600 feet at right angles to the flow of the river, and at this distance is only from 3 to 4 feet below the surface, deepening in a few yards to 8 or 10 feet, and then gradually to 22 feet, which is the uniform depth of Lake King over some miles. The tongue of land caused by the deposit in Lake King has had the effect of partly closing Jones' Bay, from which the only exit for the waters is a narrow channel leading into the submerged extension of the Mitchell.

The secondary banks separating the flats from the sloping tableland above may be traced from the devonian rocks at Boggy Creek to their termination at Bairnsdale, and again at the isolated bluff at Eagle Point. From Moitun Creek to about a mile below Lindenow township, these banks consist of fine siliceous sedimentary material near their base, and coarse above, with ironstone bands of varying thickness, and more or less fossiliferous. (See sections of Morrison's Bluff and Perry's Bluff, Figs. 8 and 10). Fossiliferous ironstone also crops out in an indentation between Perry's Bluff and Coongulmerang. Thicker bands of clayey ironstone occur in cuttings near Lindenow, and

fossiliferous ironstones on the river banks below the hotel, the State School, and Saunders' house at Lindenow itself. The ironstone and siliceous sediments shortly disappear, and the banks become less steep and slope gradually up to the higher ground. About half a mile from the ironstone outcrops, limestone shews at the foot of the bank and may be traced down to Bairnsdale, rising in places to a height of 100 feet from base to summit.

At Rose Hill, about 3 miles west of Bairnsdale, the limestone is immediately overlain by a deposit of a different character. The bank there is strewn with shells like those at Jemmy's Point, and thus of miocene age. A full description of this interesting bed will be given in the sequel.

On the upper surface of the terraced banks bounding the flats there is usually a heavy gravel wash, cemented in many places with ferruginous material and in some cases coated with manganese oxide. Similar gravel washes occur in the bed of the river, in places on the surface of the flats, and almost invariably below them. They exist also as low ridges on the tableland fully 250 feet above the present bed of the river and with included blocks weighing as much as 60 or 70 lbs. These ridges, no doubt, indicate in general the course of the old streams. They are capped with conglomerate and have worn less than the surrounding softer country. Gravel containing boulders from six to nine inches in diameter is in fact met with at least 20 miles from its source, and over 200 feet above sea level. These drift deposits, which have been extensively used for road making and railway ballasting purposes, are slightly auriferous. Indeed, the gravel washes in some parts of the Mitchell River itself, though many miles from any silurian rock, give payable returns.

The watershed on the north side of the river, so far as tertiary deposits are concerned, includes the country drained by portions of Flaggy Creek, Prospect or Boggy Creek, and Clifton Creek, as well as a few minor gullies. Near Flaggy Creek, where devonian sandstones are exposed, the country rises somewhat suddenly to the north, and thence on to Boggy Creek the river runs almost parallel to the devonian hills, and at no great distance from them. The highest eminence is Mount Taylor where devonian strata, about 400 feet in thickness, and composed of sandstones, conglomerates, and shales, rest on porphyritic rock, the upper surface

of which is over 1000 feet above the level of the creek below. Another elevated porphyritic peak, known as Granite Rock, rises a short distance to the north-east of Clifton. This is about 500 feet in height and from its summit a magnificent panoramic view of the surrounding country is presented. Between these two hills the auriferous silurian rock crops out. A series of sandy ridges, evidently of marine origin, occupies the surface from the southern flanks of the hills to the Mitchell River, the general fall of the country being in the same direction. Boulders of sandy ironstone occur here and there on the ridges, but none of those collected from a greater elevation than 200 feet above sea level contained fossil casts.

On the lower terraces the soil, which has been derived from the calciferous rock below, or from the decomposed ironstones, is fairly fertile. The upper sandy ridges are heavily timbered with eucalypts. The gravel terraces, though much less extensive on this side of the river than on the other, yet show in nearly all the sections exposed in gullies or road cuttings. On the banks of Boggy Creek, which has cut its way through some hundreds of feet of porphyritic rock, the auriferous terraces extend for over 120 feet above the present bed of the stream. Owing to the considerable mining operations formerly carried on in this creek, the bed in the lower portion of its course has become silted up, and the heavy sand is now filling the Mitchell. It is intereeting to note that by the combined action of Boggy Creek and the Mitchell River an isolated strip of calciferous rock has been left in the midst of an extensive flat. The next gully, Drevermann's, commences at Mount Lookout, and has been formed by a stream which has cut its way through the sandy drifts as far as Knight's house, on the Wuk Wuk road, and thence through the Bairnsdale limestones to the Mitchell. The only other stream of importance is Clifton Creek, which drains the silurian, devonian, and porphyritic hills to the north. After passing Hamilton's house it flows through a wide flat, thence through Boyd's, where it is bounded by silurian strata on the west, and the sand drifts and porphyritic rock on the east, and finally passes into Clifton morass. This is about two miles in length, and tapers from a mile in width at the upper end to a narrow channel at the lower. A big flood, which occurred about ten years ago, cut a channel

some thirty feet deep, through the morass, or, as it may more properly be called, peat bog, and it has since slowly drained. The surface has, in consequence, become cracked and fissured in all directions, and a subsidence of several feet has taken place. Fires lit on it have burnt in all weathers for years. After burning, the ash, incorporated with the peaty material below, forms a fair soil. The whole of this peat morass appears to have resulted from the decay of small vegetation, as it contains no timber of any size.

The limestone beds can be traced for a few hundred yards above Mr. Hope's house on the eastern side and also on the opposite bank, but higher up still only the sandy drifts appear. The morass empties itself into the Backwater, a channel of the Mitchell, which flows southward for about a mile between well defined limestone rises, then turns eastward along the limestone cliffs on the northern bank of the Mitchell, and finally joins the main stream near the Bairnsdale bridge.

From Glenaladale until just below the Lindenow bridge, the vertical sections exposed on the northern banks, show sandstone and massive conglomerate beds, which rise into rounded hills of devonian sandstones. The river flats thus lie for this distance between tertiary and devonian strata. The latter probably occur at no great depth below the Woodlands and Glenaladale properties; indeed, only a few yards above the Lindenow bridge, devonian sandstone outcrops on the flat itself.

A short distance below this point, Flaggy Creek enters the river and has exposed a fine section known as Saunders' Bluff, which will be fully described later on. Another small stream comes in about half a mile lower down, and has cut through a heavy cemented compact gravel wash which reappears as far down as Skinner's. About a mile below Saunders' Bluff there is a fossiliferous section which continues for a few hundred yards, and terminates at Skinner's, the best known collecting ground for eocene fossils on the river. At the base of this section are the calcareous beds, which are overlain by a yellow, soft fossiliferous ironstone, and this in turn is covered with sandy drift and occasional ironstone boulders. Below Skinner's, only rounded hills of the ironstone deposit are observed until the Manaro crossing or Wuk Wuk village settlement is reached. Here

again the soft fossiliferous ironstones are in evidence, and underneath them lie the compact Bairnsdale limestones. Another stretch of rounded banks extends as far as Myrtle Point, where on one side of a small gully ironstone outcrops are alone visible, while on the other a fine vertical face of calciferous rock stands out boldly. The limestone continues for some distance, and is then succeeded by rounded ironstone hills, which are traceable across Boggy Creeek, to near its junction with the Mitchell. A fine section here leads on to Dreir's, where a clayey bed, containing numerous fossils similar to those at Skinner's, extends for about 30 feet up from the water's edge, when it is sharply cut off from the tall calciferous cliff above by a shelly layer. The hard limestone rock can then be followed round the bends of the river to Captain Underwood's, almost opposite Rose Hill, where it is overlain by ironstone deposits containing numerous casts of miocene fossils. The continuation of the calciferous rock from this point to the Backwater of the Mitchell, has already been noticed.

The various sections on the river banks from which fossils have been obtained will now be described in detail.

III.—Rose Hill.

The Mitchell from Boggy Creek to Dreir's has a fairly straight course a little south of east, but then bends round and forms an extensive loop as far as Underwood's (see map). The Rose Hill section is at the western corner of the loop, and on the right bank of the river. Thence going east for some distance the stream turns north just behind the B.R.C. Hotel, but takes a westerly direction near Radford's house, until after passing the Bairnsdale Water Supply works, it again flows north towards Underwood's on the opposite bank.

Our attention was first drawn to this locality by noticing that the limestone underlying the upper rounded banks showed an unmistakable dip, and it was thus evident that an unconformity existed. We expected to find merely an ironstone deposit similar to that at Bellevue, on the other side of the river, which we had formerly examined pretty thoroughly. A search on the hills and gullies near the hotel, and thence westerly along the terrace

bounding Smith's flat, showed that ironstone outcrops containing occasional casts of miocene fossils are present, but at Rose Hill section itself these give place to calcareous clays containing unaltered miocene shells, which recall the rich fossiliferous beds at Jemmy's Point, Lake Bunga, and other places on the Gippsland Lakes. Individual examples of some species are very common, amongst which may be mentioned, Chione subroborata, C. propinqua, Tylospira coronata, Trigonia acuticostata, Ostrea arenicola, Olivella nymphalis, Turritella tristira, Tellina aequilatera, Corbula ephamilla. In all 85 species were collected, a list of which is given below. Immediately underlying the miocene marls there is the typical eocene limestone of the area, which was here evidently an eroded surface when the later beds were deposited upon it. The full section (Fig. 3) from the summit of the terrace to the flat level is:—

Clay - - - - - - - - - -	7 feet.
Conglomerate, with ferruginous cement - -	10 ,,
Clay - - - - - - - - - -	10 ,,
Clay and soft limestone, with miocene shells -	10 ,,
Marls with miocene shells - - - -	8 ,,
Nodules of limestone, with eocene shells -	20 ,,
Calciferous rock, with eocene fossils - -	4 ,,
Limestone - - - - - - - -	6 ,,
Total - - -	75 feet.

The eocene limestones continuously outcrop at the base of the hills bounding the loop, except where the river trends northerly, or between the B.R.C. Hotel and Radford's. For this distance only stratified drift is to be seen, whence it may be inferred that a channel of considerable width was there cut through the eroded limestone. Possibly the channel extended across in the direction of McLeod's morass.

Fossils from Rose Hill.

Ringicula tatei, Cossmann
Bullinella cuneopsis, Cossmann
Bullinella aratula, Cossmann
Terebra sp.*
Conus sp. (much worn)
Bathytoma pritchardi, Tate
Bathytoma sp.*
Bathytoma, n. sp.*
Pleurotoma, n. sp.
Surcula sp.*

Drillia sp.*
Drillia sp.*
Drillia sp.*
Drillia sp.*
Cancellaria sp.*
Ancilla orycta, Tate
Olivella nymphalis, Tate
Marginella propinqua, Tate
Marginella sp.*
Voluta sp. (much worn)
Uromitra euglypha, Tate
Fusus gippslandicus, Tate
Fasciolaria (?) sp.*
Fasciolaria (?) sp.
Latirus purpuroides, Tate
Phos gregsoni, Tate
Lampusia, sp.*
Lampusia, n. sp.
Tylospira coronata, Tate
Cypraea sp. (fragment)
Cerithium (?) sp.
Cerithium (?) sp.
Turritella murrayana, Tate
Turritella conspicabilis, Tate
Turritella tristira, Tate
Turritella acricula, Tate
Rissoia sp.
Crepidula unguiformis, Lam.
Calyptraea crassa, Tate
Natica subinfundibulum, Tate
Natica polita, T. Woods
Natica hamiltonensis, T. Woods
Natica cunninghamensis, Harris
Natica subvarians, Tate
Eulima, n. sp.*
Niso psila, T. Woods
Odontostomia sp. (fragment)
Trochus (?) sp.*
Calliostoma sp.
Dentalium largicrescens, Tate
Ostrea arenicola, Tate
Placunanomia ione, Tate
Spondylus, n. sp.
Limea, n. sp.
Pecten antiaustralis, Tate (juv.)
Cucullaea corioensis, McCoy
Limopsis forskali, A. Adams
Glycimeris laticostata, Q. and G.
Nucula antipodum, Hanley
Leda vagans, Tate
Leda woodsii, Tate
Trigonia acuticostata, McCoy
Cardita spinulosa, Tate
Cardita, n. sp.*
Crassatellites oblonga, T. Woods var.
Kellia micans, Tate
Cardium sp.
Meretrix paucirugata, Tate
Meretrix, n. sp.
Chione cognata, Pritchard
Chione subroborata, Tate
Chione propinqua, T. Woods
Chione allporti, T. Woods
Dosinia sp., *aff.* D. johnstoni†
Tapes, n. sp.*
Zenatiopsis angustata, Tate
Corbula scaphoides, Hinds
Corbula ephamilla, Tate
Panopaea australis, Sow.
Barnea tiara, Tate
Tellina aequilatera, Tate
Tellina albinelloides, Tate (?)
Cuspidaria, n. sp.
Aspergillum sp.
Trematotrochus clarkii, Dennant

IV.—Bellevue.

The ironstone conglomerates of this section were examined several years ago, and before the Rose Hill bed on the opposite bank was discovered. It is situated about two miles from Bairnsdale and immediately on the terrace bank of the river. Many visits have been paid to the locality, and we have to thank Captain Underwood, who owns the farm, for valuable assistance in the researches made. The ironstone is fresh looking, and the fossil casts in it are exceptionally sharp and distinct. We broke

* Also in the Gippsland Lakes miocene.
† Also at Table Cape.

up a very large quantity of the material and were able to identifiy the species named below. We may state here, that in the identification of these and all other fossils from an ironstone matrix mentioned in the present paper, we availed ourselves of the critical knowledge of tertiary mollusca possessed by the late Professor Tate—in fact, the several lists offered of ironstone fossils from Bellevue, Moitun Creek, Village Settlement, and Lindenow, were drawn up in consultation with him. For the most part, moulds in wax have been prepared, which can be consulted whenever occasion arises.

Fossils from Bellevue.

Roxania, sp.
Nassa sublirella, Tate
Phos gregsoni, Tate
Lampusia, n. sp.*
Tylospira clathrata, Tate
Turritella tristira, Tate
Turritella acricula, Tate
Natica cunninghamensis, Harris
Leiopyrga quadrisulcata, Tate
Calliostoma, sp.*
Modiola, two spp.
Modiola, sp.†
Glycimeris laticostata, Q. and G.
Cucullaea corioensis, McCoy
Leda woodsii, Tate
Trigonia howitti, McCoy
Trigonia acuticostata, McCoy
Crassatellites oblonga, T. Woods
Chione propinqua, T. Woods
Chione subroborata, Tate
Meretrix, sp.
Dosinia johnstoni, Tate
Mactra axiniformis, Tate
Corbula ephamilla, Tate
Zenatiopsis angustata, Tate
Tellina albinelloides, Tate
Myadora corrugata, Tate
Lunulites rutella, T. Woods
Lovenia forbesi, T. Woods

One of the ironstone blocks containing several marine fossil casts, shews also a well preserved leaf impression (species undetermined), and it is evident therefore, that the deposit was a strictly littoral one.

The most frequently recurring species are Trigonia howitti, Chione propinqua, Zenatiopsis angustata, Leda woodsii, Leiopyrga quadricingulata, and Lovenia forbesi. Less common, but still tolerably abundant, are Chione subroborata, Tylospira clathrata, Turritella acricula. The remainder are, as a rule, represented in our gatherings by single specimens only. With few exceptions, the same species are abundant throughout the calcareous beds of the Gippsland miocene as well as in equivalent strata at Rose Hill.

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* Also in the Gippsland Lakes miocene.
† Also at Spring Creek.

The Bellevue bank, as measured by levelling from Captain Underwood's doorstep, is 146 feet above the river level. (See Figs. 4 and 5 for sections at Bellevue). A section exposed on the face of the cliff overlooking the river gives :—

Ferruginous blocks, with miocene fossils -	14 feet.
Clay - - - - - - - - - -	4 ,,
Limestones (eocene), with fine gravel - -	10 ,,
Yellow limestone (burnt for lime) - -	4 ,,
Alternate beds of hard and clayey limestone, with eocene fossils - - - - -	70 ,,
Talus to river level - - - - -	30 ,,
Total	140 feet.

A little back from the cliff and on the slightly sloping bank, a heavy gravel wash shows in a quarry, referred to below, and then farther up still a ferruginous sandy conglomerate. The fall of the river from Underwood's down is very slight, the surface of the water at the section quoted, being only six feet above sea level.

There is a deep gully close to the house, and a section across it is given in Fig. 4. On both sides the hard calciferous limestone can be seen outcropping here and there among the grass, until towards the summit the overlying fossiliferous ironstone and heavy gravel wash successively appear.

The quarry shown in Figs. 4 and 5 was excavated to obtain gravel for road making, and at its base a portion of a fossilized tree three feet long, and two feet in diameter, was uncovered. The log has not been removed, and was thus seen by us *in situ*. It is coated all round with ferruginous gravelly material to a thickness of some inches, while the internal part consists largely of decayed vegetable matter. The top of the quarry which is 13 feet below Bellevue House, and therefore 139 feet above sea level, represents nearly the highest point at which miocene casts were obtained. The house is built on the river terrace and not on the summit of the bank, which is reached by a gradual slope at a further height of 105 feet. The strata consist mainly of gravels, sands, and clays, with here and there ironstone blocks enclosing pebbles, but apparently unfossiliferous. The same remark applies to ironstone at Clifton, near at hand, and also to

scattered surface blocks at a much higher level on the Bulumwaal road.

The pebbly drift in the Bellevue quarry is very coarse, and on one side fully 12 feet thick. Many of the larger stones lying on the floor are lenticular in shape, and as much as a foot in length, by eight to nine inches in breadth. On the face of the quarry the stones are of various sizes, and the larger ones mentioned have probably been rejected when the material was carted for road making.

At first sight it might easily be supposed that the pebble drift is interstratified with the fossiliferous ironstone, as it crops out not only at a higher, but also at a lower elevation even in contiguous exposures. In the quarry some few blocks apparently overlie gravel, but this we think is due to slipping. After protracted observation and much consideration, we decide that the gravel drift is younger than the fossiliferous miocene ironstone. Reference to Figs. 4 and 5 will shew our interpretation of the evidence presented at Bellevue.

As before mentioned, the gravel is wide spread, and is especially displayed in road cuttings south of the river, between Bairnsdale and Lindenow. At the latter locality the river is fordable in summer, and, though a large volume of water is always flowing, the greater part of the channel, which is sometimes 300 to 400 feet in width, becomes dry. A large extent of the river bed is thus exposed, and consists entirely of loose stones like those at Bellevue. Similarly at Bairnsdale the gravel is abundant, and has been freely used in making the roads of the shire. On the north of the river the gravel deposits, though fairly thick in places, are less extensive than those on the south side. At Underwood's, as we have seen, and also in a cutting in Dreir's lane, much gravel is present. Again, there is a heavy conglomerate, 10 feet thick, at Skinner's, and another towards Saunders' Bluff, both being terrace deposits.

The origin of the gravel drift is not in doubt. It is clearly derived from the waste of the devonian, silurian, and porphyritic rocks to the north. The majority of the pebbles consist of sandstone, but among them are fragments of porphyry and quartz. Though much weathered, the larger porphyritic pebbles, when fractured, sometimes reveal an internal core of scarcely altered

rock. From Lindenow on to the west, devonian rock masses may still be seen *in situ* in the river bed and together with their associated porphyries they no doubt formed the coast line during the deposition of the earlier tertiaries from Lindenow to Moitun Creek. These ancient rocks, however, are at a considerable distance from Bairnsdale and Bellevue, so that the gravels there must have been brought down by the river itself or by other streams from the north. As we shall presently shew, there is undoubted evidence of drifts due to coast action at Moitun Creek, Lucas Creek, etc., but the coarser and far more widely spread gravels now under consideration have, we think, been largely transported by running water.

The relation of the gravels to the miocene ironstone has been chiefly studied at Bellevue, where alone the contact of the two deposits is well displayed, and the following extracts from notes taken on the spot will explain our views upon the somewhat complex problem presented.

The gravel appears to be merely a terrace deposit due to an old stream. It is too coarse for simply marine wash, being so far removed from its source. It can be traced westward for some distance, and since it does not extend laterally into the hill, it clearly represents a channel cut through the old miocene bed. Reference to Fig. 5 shews that in the quarry gravel occurs at a lower elevation than an exposure of the fossiliferous ironstone, but this is explained by supposing that the drift has cut away portions of the bed and has left blocks of ironstone, which now protrude here and there, through the gravel. Though in places at a higher level than the latter they are the older strata. On levelling across from the quarry to Underwood's garden the fossiliferous blocks were met with at the same elevation; the gravel is above, while beneath there is no gravel, but only clay and ironstone. A flag-post hole was lately sunk in front of the house to a depth of six feet through this gravel, so that the latter is there on the top. It may be added, also, that, though occasional loose blocks of fossiliferous ironstone are found comparatively high up on the banks, the gravel invariably shews higher still.

The precise age of the gravel drifts is doubtful. So far as the evidence goes they may be of any age from pliocene to recent. They are probably contemporaneous with the formation of the

river channel, at least in this part of its course. In many places they are left high up on the banks of the river, which has since cut its channel deeper and deeper into the underlying limestone. Frequently they have been redistributed, and, as at Lindenow, now rest in the actual bed of the stream.

Next in order to the ironstone conglomerate come the well known Bairnsdale limestones. They are of unknown thickness here, but terminate abruptly as the river is followed up. They may be briefly described as hard compact rocks, rich in fossils, which, however, with the exception of a few species of pectens, a large oyster, several brachiopods, and occasional examples of other forms occur as calciferous casts only. Lists of the species recognised in various outcrops of the strata have been previously given (4 and 6), and need not be now repeated. For miles along the Mitchell as well as on the Nicholson and Tambo Rivers, at Lake Tyers, and as far east as Snowy River, the same eocene rocks are presented. At Bellevue the upper portion of the limestone for several feet down shews numerous very small siliceous pebbles, with here and there a larger one scattered irregularly through it. All of them are ironstained, much rounded, and worn. We have not observed similar pebbles in exposures of the rock elsewhere. There is no question here of a remade bed, the junction of the two strata, viz., eocene and miocene being sharply defined. Both are apparently horizontal, and thus comformable. Still the exposure in the upper deposit is too small to allow of a positive statement under this head.

V.—Knights.

On the Wy Yung road, north of the Mitchell, and between Bairnsdale and the section just described, a small road cutting displays a similar ferruginous conglomerate, but the fossil casts, owing to the prolonged weathering of the material, are usually indistinct, Trigonia howitti and Myadora corrugata being the only ones we could definitely name. Under the ironstone a moderately stiff clay, containing from 40 to 50 per cent. of coarse waterworn sand, reaches down to the road level. The junction line of the two strata is uneven, slight hollows in the sands and clays being filled by the ironstone. As the latter continues on the hilly ground beyond the top of the cutting, its thickness could

not be accurately estimated. The cutting itself is about 145 feet above sea level, or at the same height as the Bellevue section. Isolated boulders of fossiliferous ironstone can also be traced in the neighbourhood of this cutting for a further height of 15 feet. There is no gravel associated with the ironstone here. From Knight's to Bairnsdale the country falls, and the eocene limestone outcrops on the river banks with pebble drift resting immediately upon it.

In a former paper (6) we traced the northern boundary line of the Gippsland miocene from Red Bluff to the Nicholson River, but the discovery of the ironstone casts at Knight's and Bellevue, as well as of unaltered miocene shells at Rose Hill permits of the continuation of this line for at least eight miles farther west. Between Knight's cutting and the Nicholson the miocene has not been observed, but its existence in portions of the area immediately north of Bairnsdale is not improbable.

In geographical order going up the river from Bellevue, the section at Drier's comes next, but as in one important respect this resembles Skinner's, it will be described in conjunction with the latter, and we pass on to

VI.—Boggy Creek.

On the Government maps this stream is now noted as Prospect Creek, but we retain the old name for the sake of reference to earlier descriptions. It empties into the river through a wide flat. In summer the actual channel is narrow, and confined to the eastern margin of the flat. At the southern end and abutting on the river there is a fine cliff of eocene limestone 194 feet in height above datum line (sea level), and very steep, a fact which was forcibly impressed on our minds when climbing it on a very hot day. The bank bordering the flat on the eastern side is much lower, rounded, and with a more gradual slope; it continues for about three quarters of a mile, and encloses a kind of amphitheatre reaching up to the road. Where the traffic bridge crosses the creek, the flat narrows abruptly, but widens out again on the north. On both sides of the creek the ascent to the general level of the country is steep; by actual levelling the highest part of the road, near Dooley's gate on the western slope, was found to be 230 feet above datum line.

At the summit of the limestone cliff overlooking the river we found no ironstone. The rounded banks of the creek farther from its mouth are covered with soil, but here and there the limestone crops out, or shews in wombat holes round the base of the hill up to the bridge. In addition, there are numerous boulders of sandy ironstone containing very distinctly marked fossil casts. These boulders continue from near the creek level almost to the top of all the hills in the amphitheatre, with the exception of the tall cliff at the extreme south. When we first saw the ironstone boulders we somewhat hastily concluded that they contained miocene fossils similar to those gathered at Bellevue, and we commenced to break them up in order to enrich our collection. To our surprise, however, we obtained instead a typical eocene fauna, as will be seen from the following list of species determined:—

Fossils from Boggy Creek.

Bullinella, sp.
Roxania woodsii, Tate
Conus, sp.
Volutilithes antiscalaris, McCoy
Voluta maccoyii, T. Woods
Fasciolaria sp.
Latirus murrayanus, Tate
Lampusia woodsii, Tate
Lampusia annectans, Tate
Apollo prattii, T. Woods
Semicassis transenna, Tate
Cypraea, two spp.
Potamides semicostatum, Tate
Turritella murrayana, Tate
Turritella tristira, Tate
Natica, sp.
Emarginula wannonensis, Harris
Dentalium mantelli, Zittel
Spondylus pseudoradula, McCoy
Hinnites corioensis, McCoy (prob.)
Pecten murrayanus, Tate
Modiola pueblensis, Pritchard
Glycimeris laticostata, Q. and G.
Limopsis forskali, Adams
Cucullaea corioensis, McCoy
Cardita polynema, Tate
Cardium victoriae, Tate
Meretrix submultistriata, Tate
Chione dimorphophylla, Tate
Mactra howchiniana, Tate
Panopaea orbita, Hutton
Cuspidaria subrostrata, Tate
Magasella woodsiana, Tate
Flabellum gambierense, Duncan
Flabellum victoriae, Duncan
Placotrochus deltoideus, Duncan

These fossils, or at least nearly all of them, are also common in the prolific shell beds at Skinner's and Drier's (see post), which we regard as on the same geological horizon as the Bairnsdale limestone, the relative abundance of certain fossils in the two sets of strata being chiefly due to altered sedimentary conditions. Further reference to this matter will be made later on. At Boggy Creek both strata are represented, the first by the fossiliferous ironstone, and the second by the adjoining calciferous rock.

Amongst the ironstone strata of the amphitheatre banks, we picked up several unaltered oyster shells similar to those in the river cliffs. In occasional blocks, also, we found that the substitution of the iron oxide for limestone was partial and confined to the outer portions of the stone. Specimens from the latter have not been quoted in the list, but only those which occurred as casts in fully altered rocks. For the most part, the nodules of fossiliferous ironstone crop out at a comparatively low level, but some resting on the tops of the rounded hills bordering the flat, and others still higher up on the eastern slope of the road yielded, when broken, good fossil casts.

Besides the exposure of the limestone on the southern cliff and at the base of the low hills along the creek, there is a small inlier on the roadside at the eastern approach to the bridge. This has been quarried and a face about 35 feet high is left (see Sec. Fig. 6). The rock here is much weathered and also hardened superficially by redeposit of calcium carbonate, but a few shells were detected in it, viz., Spondylus gaederopoides, Pecten yahlensis, and P. gambierensis.

The full section at the quarry is :—

Surface soil - - - - - - - -	6 feet.
Clay - - - - - - - - -	8 ,,
Projecting limestone layer, coated with ironstone, and containing calciferous casts of fossils - - - - - - -	2 ,,
Fine sand and efflorescing salts - - -	10 ,,
Nodules of limestone and silt, with very small worn quartz pebbles - - -	9 ,,
Total	35 feet.

The hill on the west side of the creek leading up to, and beyond Dooley's gate, is a counterpart of that on the other side, except that no limestone is visible at the base. Section Fig. 6, shews the strata on the western ascent, the steepness being, to save space, greatly exaggerated. The alternating layers of drift and soft ironstone bands occur up to the summit. The summit itself, is capped with the bed of an old stream, the bottom of the channel being well defined ; the silt has been cut into, and

the pebbles and stones are cemented together, giving a hard conglomerate cap which has weathered less than the surrounding softer material. The fine drift sand on this side suggests sedimentation from a river current, which emptied into the eocene sea, near the present mouth of Boggy Creek. The sediments are of course marine, and practically contemporaneous with the deposition of the limestone on the eastern bank.

A short distance up the western rise from Boggy Creek, and just before reaching Dooley's gate, there is a road cutting, in which a thickness of 8 or 10 feet of massive ironstone is exposed. Its elevation is 160 feet above sea level, and, though unpromising looking for fossils, we ultimately found a layer shewing numerous casts, amongst which we identified the following species :—

Conus sp.
Lampusia sp.
Spondylus gaederopoides
Pecten foulcheri
Pecten gambierensis
Glycimeris laticostata
Cardium sp.
Magellania insolita
Echinoderm (spine)
Placotrochus deltoideus

These fossils of course stamp the outcrop as eocene, which thus extends upwards at Boggy Creek, and does not give place in the higher levels to the Bellevue miocene. Again, on the southern cliff, at the mouth of the Creek, which is 194 feet above datum line, and thus fully 40 feet higher than Bellevue, the topmost strata are still eocene. In fact, after leaving Underwood's, we found no further trace of the miocene westward, though we made most diligent search.

At Myrtle Point, about a mile further west, we again struck the river. Ironstone is here abundant just below the summit of the cliffs as well as in places down the bank. Many boulders were broken up but the fossil casts were rare and mostly indistinct ; we identified only Magellania insolita, and Cardita delicatula from this outcrop. In many blocks we noticed very small fragments of decayed wood.

Before leaving the Boggy Creek Section we remark that the fossils obtained by Mr. Howitt in his researches in this area were submitted to Sir F. McCoy, who classed those from the ironstones of Boggy Creek and Moitun Creek as upper miocene or lower pliocene, and younger than the Bairnsdale limestones, which he placed in the middle miocene (1). The distinction in age thus drawn between the calciferous and ferruginous beds at

Boggy Creek is, as we have indicated, an error. There is no break in the series, both sets of strata, though differing lithologically, being on the same geological horizon. According to the views now current concerning the age of the Australian tertiaries, the deposits are classed as eocene and not miocene.

VII.—Moitun Creek.

This, the extreme westerly section examined, is the most typical one from which ironstone casts belonging to the older group of the Mitchell tertiaries have been obtained. As already stated, Moitun Creek enters the Mitchell River just at its great eastern bend. At this junction the river flat is 108 feet above sea level. A fine section here (Fig. 7) shews towards its base hard yellow sandstone and then sand and drift with fossiliferous ironstone in layers up to a height of 113 feet. Resting upon the topmost ironstone layer there is about 17 feet of gravel wash, with stones in it as much as 6 inches in diameter. The summit of the cliff is 140 feet above the river, but the country still rises and heavy gravel washes may be traced up to a height of 200 feet. Our chief collecting ground was not at the junction, but about half a mile west, on the south bank of Moitun Creek. A section at Morrison's Bluff, which rises steeply from the margin of the creek (Fig. 8), reads thus :—

Surface soil and gravel	25 feet.
Massive conglomerate	5 ,,
Ironstone layers, with fossils and sandy drift	9 ,,
Pebbly gravel	5 ,,
Yellow sandy clay	6 ,,
Ironstone, highly fossiliferous	2 ,,
Pebbly cemented gravel	8 ,,
Fine yellow sand, with ferruginous pipes and talus	50 ,,
Total	110 feet.

A few chains further west, and close to the road over Moitun Creek, leading to Iguana Creek, the tertiaries rest directly on

devonian shales, the sequence of the strata from the creek bed to the level of Morrison's house being :—

Gravel and clay - - - - - -	35 feet
Ironstone bands, with fossils - - -	27 ,,
Devonian shales - - - - - -	48 ,,
Total	110 feet.

These measurements are only up to the terrace bank on which the house stands. The hill, still shewing drifts and gravel washes, continues by a gradual slope up to Morrison's gate on the main road, where an elevation of 250 feet above the river was recorded.

A longitudinal section at the actual contact of the tertiary and devonian strata is given in Fig. 9. Three bands of fossiliferous ironstone, interstratified with sands and gravels, occur in a vertical height of 48 feet. Both in Morrison's Bluff and at the contact section, fossil casts were collected from near the base up to the summit of the terrace; the most prolific ironstone bands were, perhaps, one just under the terrace level and another adjoinining the contact section. The blocks collected are full of fossils and a great variety of species is represented. On the whole, the casts are inferior in clearness to those at Boggy Creek, and a larger quantity of material was broken up to obtain examples which could be definitely named. Impressions in wax or plaster were taken in almost every case.

Fossils from Moitun Creek.

Actaeon scrobiculatus, T. Woods
Scaphander tenuis, Harris
Bullinella exigua, T. Woods
Mangilia (?) sp.
Marginella winteri, Tate
Marginella woodsii, Tate
Marginella sp.
Volutilithes antiscalaris, McCoy (?)
Fusus dictyotis, Tate (prob.)
Latirus sp.
Trophon sp.
Tritonofusus sp.
Typhis evaricosus, Tate
Lampusia tortirostris, Tate
Turritella tristira, Tate
Turritella murrayana, Tate
Rissoia vel Rissoina sp.
Calyptropsis turbinata, T. Woods
Natica polita, T. Woods
Natica vixumbilicata, T. Woods (?)
Eulima sp.
Cantharidus sp.
Dentalium sp.
Glycimeris cainozoica, T. Woods
Glycimeris laticostata, Q. and G.
Limopsis morningtonensis, Pritchard
Cucullaea corioensis, McCoy
Nucula tenisoni, Pritchard
Leda woodsii, Tate
Cardita compacta, Tate (?)

Cardium victoriae, Tate (?)
Panopaea orbita, Hutton
Meretrix eburnea, Tate (?)
Chione allporti, T. Woods
Chione etheridgei, Pritchard
Chione propinqua, T. Woods
Chione, n. sp. (also at Skinner's)
Chione cainozoica, T. Woods
Dosinia densilineata, Pritchard
Psammobia aequalis, Tate (?)
Zenatiopsis angustata, Tate
Corbula ephamilla, Tate
Sphenotrochus emarciatus, Duncan
Deltocyathus viola, Duncan (?)
Deltocyathus (?) sp.

A comparison of this list with that given for Boggy Creek shows some variation in the species represented. This is doubtless owing to the more littoral character of the Moitun Creek deposit. Its fauna is apparently allied to that at Table Cape, on the north coast of Tasmania, which is admittedly a strictly littoral one.

The outcrops of the fossiliferous ironstone at Moitun Creek are confined to the steep southern bank: beyond the flats on the north the strata consist of the devonian sandstones and conglomerates, which continue up to Iguana Creek, the weir on the Mitchell, and thence for a long way northwards. It is especially important to note that there is no limestone at Moitun Creek, nor indeed for several miles to the east to it; the actual limits of this rock on the Mitchell will be indicated directly.

At the mouth of Lucas Creek, which is about two miles east in a direct line from the Moitun Creek junction, there is a bold cliff on the Mitchell called Perry's Bluff. The sediments are mostly very fine, and often almost a pipe clay. The strata are horizontal, and from the surface downwards consist of :—

	Ft.	In.
Ironstone	6	0
Heavy gravel wash	15	0
Ironstone band	about 4	0
Sandy cement, with ironstone pipes	40	0
Layers of ironstone	about 3	0
Sandy cement	5	0
Ironstone pipes (basic sulphate of iron, efflorescent)	2 to 3	0
Cemented fine sand, highly coloured	15	0
Ferruginous pipy layers	0	9
Very fine cemented sandy material	6	0
Total—about	97	9

The cliff itself is almost vertical but above it the ground slopes gradually and shews 20 feet of sand to the hill top. Details of this section are also given in Fig. 10. There are innumerable casts of small shells right through the sandy drift material, but they cannot be identified.

It is seen from the several sections in the neighbourhood of Moitun Creek that the strata exposed consist of fine sediments, with which layers of fossiliferous ironstone, and also heavy gravel washes are interstratified. Since the shore line here during the deposition of the eocene was evidently formed of the devonian strata, the drifts and conglomerates may in some measure be accounted for by coastal action. They must, however, be mainly due to mountain streams, including the Mitchell itself, which brought down both fine and coarse sediments and distributed them near the confines of the subsiding sea. The Mitchell River in eocene times probably discharged near Moitun Creek and the sediments which came down are represented by the silts and gravels constantly disclosed in the river sections. The ironstone forms only a small proportion of the total material in the cliffs. Not only the ironstone, but also the cemented sandy drifts are sometimes fossiliferous and we may conclude that in part, at least, they are altered representatives of shell beds similar to those at Dreir's and Skinner's.

With regard to the more elevated sands and gravels displayed in the same sections fossil evidence for the determination of their age is so far wanting. They rise by a gentle slope from the main terrace on the south bank of the river up to the general level of the country.

VIII.—Dreir's.

Reference to the map (Fig. 1.) will shew that this section is situated about midway between Bellevue and Boggy Creek. It consists of a thickness of 70 feet of typical Bairnsdale limestones at the top and beneath them 30 feet of calcareous sands and clays full of well preserved gastropods and lamellibranchs. The two sets of strata are separated by a shelly band. A dip varying from 5° to 10° was noted in the limestone; in most outcrops of such strata on the Mitchell the bedding is horizontal. A sketch of Dreir's cliff is supplied in Fig. 11. The sequence of the

calciferous rock and clays here is notable, since in the contact of equivalent strata on the Moorabool this order is reversed.[1]

Some years ago a fine collection of fossils was made from the lower strata, the names of which we will include with those from a similar deposit at Skinner's, higher up the river. Unfortunately, further collecting at Dreir's is for the present extremely difficult, the outcrop being now almost completely hidden, partly by alluvium and sand washed over it by floods, and partly by the dense undergrowth which afterwards sprung up.

IX.—Village Settlement.

This section is on the north bank of the river, and between Myrtle Point and Skinner's. Some clearly marked fossil casts were extracted from ironstone blocks cropping out on a road leading down to the river, which is here 38 feet above sea level. The lower portion of the bank is occupied by the usual Bairnsdale limestone, and at a height of 50 feet above the river level this gives place to soft fossiliferous ironstone. A short stay sufficed to shew us that the casts resemble those at Boggy Creek, as is indicated by the following examples :—

Fossils from Village Settlement.

Cypraea pyrulata
Turritella, sp.
Spondylus gaederopoides, McCoy
Spondylus pseudoradula, McCoy
Pecten gambierensis, T. Woods, var.
Pecten foulcheri, T. Woods
Glycimeris laticostata, Q. and G.
Limopsis insolita, G. B. Sow. (prob.)
Chione, sp.
Panopaea orbita, Hutton
Corbula ephamilla, Tate

X.—Skinner's.

Going a little further west we come to Skinner's, where a series of sections extend for about half a mile along the northern bank. Since the silting up at Dreir's, this is now the only locality on the river in which well preserved eocene fossils can be collected ; in the ironstone they are, as we have seen, reduced to casts, while in the Bairnsdale limestone unaltered forms are rarely found.

The earliest section worked is at the base of a steep bank directly under Skinner's house. An almost similar section,

[1] Hall and Prichard: Notes on Lower Tertiaries of Southern Portion of Moorabool Valley. R. S. Vic., vol. iv., n.s., 1892.

a few chains farther west, is only accessible on foot when the river is low, but it is, we believe, a more profitable bed for the collector than the other. We reached it in the first instance by means of a duck boat, a mode of conveyance we cannot recommend to geologists, as by some mischance one of us was suddenly tumbled headlong into the river. In addition to the larger forms of mollusca the strata are replete with small shells, corals, bryozoa, foraminifera, etc., which can be easily washed out of the friable matrix. In both sections the shell beds are at the base of the bank and under compact limestone, but in contrast to Dreir's, the latter no longer constitutes the main mass of the strata, alternations of sandy drift and ironstone occurring up to the conglomerate capping at the summit of the terrace. A drawing is given of the more westerly of these sections in Fig. 12, the strata observed being,

Sand and Clay on the sloping ground back from the terrace, and then :—

Massive cemented conglomerate - - -	15 feet
Silt and ironstone bands - - - -	15 ,,
Sandy drift - - - - - - - -	15 ,,
Clayey ironstone band, with cocene fossils -	1 ,,
Sandy drift - - - - - - - -	14 ,,
Compact limestone - - - - -	4 ,,
Fine sandy drift, with ferruginous pipes, similar to the high level beds at Dooley's (Boggy Creek) - - - - -	9 ,,
Loose calcareous beds (fossiliferous) - -	13 ,,
Compact shelly beds down to river level -	9 ,,
Total	95 feet.

The river here is 46.55 feet above sea level.

At another section, a little farther west still, the strata are much the same, but the basal bed consists of 25 feet of the calcareous material similar to that worked some years ago at the first section, or Skinner's proper, when the majority of the fossils listed below were collected.

In the half mile stretch between Skinner's and the gully, which breaks through the banks westward, many good sections were

noted, but in this short distance they shew a surprising variation in character. This is to some extent the result of alteration since the deposition of the strata, but the chief cause is undoubtedly changes in the sediments. A few hundred yards west of the last section, the calcareous strata disappear entirely at the base and cemented ironstone or only sandy drift occurs for several feet up, while overlying there are nodules and even bands of hard unaltered limestone. A few yards farther west still, i.e., near the gully mentioned, this in its turn disappears. The lower silt is full of the ferruginous pipes and stems common at Dooley's and other sections, and there appear to be also the remains of bryozoa (though on this point we cannot be positive).

We have only recently been able to observe these final sections on Skinner's bank: at previous visits the steepness of the bank and the thick scrub covering it, combined with the approach of the water to the very edge, rendered the place practically inaccessible, but on the last occasion we managed to clamber all over the face.

On the other side of the gully, the massive conglomerate capping and a thickness of 15 to 20 feet of ironstone overlie the sandy drift. This ironstone may be traced westward for about a mile, and is no doubt the same as that which caps Saunders' Bluff. The layers at the base of the latter correspond to those at the west end of Skinner's, about a mile and a half away. Since Saunders' Bluff is practically at the end of the eocene on the north side of the river, the old coast line must have been close to the sections noted, and it is thus fair to conclude that the variation in the strata is mainly due to sedimentation.

We observe that on this side of the river, the limestone at Myrtle Point is of great thickness and constitutes the main mass of the bank, yet at Skinner's section close at hand it is reduced to a thin band. Again, on the south bank, the limestone passes with surprising suddenness into the drift deposits. On the western flank of the Mitchell tertiaries there is thus no gradual thinning out of the limestone, and it cannot, as Mr. Howitt's theory requires, be an eroded basal bed upon which the sandy drifts, with their alternating fossiliferous ironstones, have been subsequently deposited (1). On the contrary, we regard the strata, including the limestone, gastropod beds, and other

sediments, as practically contemporaneous, that is, they belong to the same horizon of the eocene. It is true that both at Dreir's and Skinner's, the calcareous shell beds underlie the Bairnsdale limestone, and must therefore have been first laid down, but at Boggy Creek the ironstones of the amphitheatre, in which similar fossils are now represented by casts, actually overlie the same limestones. Those who have studied the marine tertiaries of Southern Australia, will doubtless recall somewhat analogous occurrences in the eocene of other localities. The relationship of certain well-known calcareous or clay beds, with a rich assemblage of fossils, to adjoining polyzoal limestone has been discussed in various memoirs, and it will suffice to say here that their close palaeontological affinities are now generally recognized. The proximity of the former shore line renders the solution of the problem for the Mitchell sections comparatively easy. The creeks or rivers which discharged into the eocene sea would bring down sands and clays, and a favourable matrix for the preservation of the tests of gastropods, corals, etc., would thus exist, while in the quiet clear waters of areas removed from the action of such currents, the faunal remains might at the same time accumulate as beds of limestone. In the latter, oysters, some species of pectens, echinoderms, etc., are usually more abundant than in the clays, while univalve mollusca are comparatively scarce. The preponderance of certain fossil forms in the respective strata may probably be accounted for by the nature of the enclosing media. Though the large majority remain intact only in the clays and calcareous sediments, a few are certainly best preserved in the limestones. Attention may here be called to Mr. F. W. Harmer's description of the Coralline Crag of Suffolk (England), wherein he states that pectens and other mollusca with calcitic tests, and the remains of bryozoa are common, but the opaque or aragonitic mollusca are represented by casts only[1].

Similar remarks are applicable to the Bairnsdale limestones. In some portions of the latter, as at Swan Reach (5), casts of gastropods, though not plentiful, yet occur, but they are rarely identifiable.

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[1] Q.J.G.S., vol. liv., p. 321.

As already shewn by Messrs. Hall and Pritchard, it is by no means necessary to assume that the limestones of tertiary beds represent deep water deposits.[1] It follows of course from what we have stated that the limestones in this part of the Mitchell area could not have been laid down at any great distance from the shore, and the views expressed by the authors named are thus here of special application.

A list of fossils from Skinner's was given by one of us a few years ago (5), but the present opportunity is taken of adding to as well as of revising it. As before intimated, species from the equivalent bed at Dreir's are now included.

We have to thank Mr. Wallace for the use he allowed us to make of his collection of Skinner's fossils.

Fossils from Skinner's and Dreir's.

Gasteropoda.

Semiactaeon microplocus, Cossmann
Bullinella angustata, T. and C.
Bullinella infundibulata, Cossmann
Bullinella aratula, Cossmann
Bullinella cuneopsis, Cossmann
Umbraculum australe, Harris
Conus pullulescens, T. Woods
Conus cuspidatus, Tate
Conus, sp.
Bathytoma angustifrons, Tate, var.
Columbarium acanthostephes, Tate
Columbarium craspedotus, Tate
Pleurotoma clarae, T. Woods
Pleurotoma murndaliana, T. Woods
Pleurotoma trilirata, Harris
Pleurotoma, n. sp.
Pleurotoma, sp.
Borsonia, sp.
Drillia sandleroides, T. Woods
Drillia stiza, T. Woods
Drillia integra, T. Woods
Drillia, three spp.
Buchozia hemiothone, T. Woods
Cordiera conospira, Tate
Daphnobela gracillima, T. Woods
Mitromorpha daphnelloides, T. Woods
Mitromorpha, two spp.
Clathurella bidens, T. Woods
Clathurella, two spp.
Mangilia, spp.
Cithara, sp.
Cancellaria platypleura, Tate
Cancellaria varicifera, T. Woods
Cancellaria epidromiformis, Tate
Ancilla pseudaustralis, Tate
Marginella wentworthi, T. Woods
Marginella winteri, Tate
Marginella micula, Tate, var.
Marginella, two spp.
Volutilithes antiscalaris, McCoy
Voluta weldii, T. Woods
Voluta maccoyii, T. Woods
Voluta conoidea, Tate
Mitra atractoides, Tate, var.
Uromitra paucicostata, Tate
Uromitra, two n. spp.
Fusus dictyotis, Tate
Fusus senticosus, Tate
Latirofusus exilis, Tate
Fasciolaria, sp.
Latirus salebrosus, Harris
Siphonalia, n. sp.
Phos tardicrescens, Tate
Phos (?) n. sp.
Nassa tatei, T. Woods
Columbella funiculata, T. Woods
Columbella, five spp.
Trophon, sp.
Murex rhysus, Tate
Murex lophoessus, Tate
Murex polyphyllus, T. Woods

[1] Tertiary Deposits of the Aire and Cape Otway. R.S.V., vol. xii., n.s., 1899.

Murex, n. sp.
Lampusia woodsii, Tate
Lampusia tortirostris, Tate
Lampusia gemmulata, Tate
Apollo prattii, T. Woods
Cassis exigua, T. Woods (?)
Cypraea gigas, McCoy
Cypraea leptorhyncha, McCoy
Cypraea eximia, G. B. Sow.
Cypraea parallela, Tate
Cypraea pyrulata, Tate
Trivia avellanoides, McCoy
Triforis wilkinsoni, T. Woods
Triforis sulcata, T. Woods
Triforis, sp.
Cerithium apheles, T. Woods
Colina, two spp.
Newtoniella eusmilia, T. Woods
Newtoniella cribarioides, T. Woods
Newtoniella, eight spp.
Thylacodes conohelix, T. Woods
Tenagodes occlusus, T. Woods
Turritella platyspira, T. Woods
Turritella murrayana, Tate
Turritella tristira, Tate
Turritella acricula, Tate
Torinia, sp.
Rissoia tateana, T. Woods
Rissoia, five spp.
Rissoina, two spp.
Calyptropsis turbinata, T. Woods
Natica hamiltonensis, T. Woods
Natica polita, T. Woods
Natica subinfundibulum, Tate
Scalaria, spp.
Crosseia (?) sp.
Eulima danae, T. Woods
Eulima, two spp.
Niso psila, T. Woods
Pyramidella, n. sp.
Odontostomia, sp.
Eulimella, two spp.
Turbonilla, sp.
Turbo, n. sp.
Collonia parvula, T. Woods
Collonia, sp.
Cantharidus, three spp.
Gibbula, three spp.
Trochocochlea, sp.
Chlorostoma (?) sp.
Calliostoma, three spp.
Astele, two spp.
Euchelus, sp.
Liotia roblini, T. Woods
Tinostoma, sp.
Fissurellidea malleata, Tate
Emarginula wannonensis, Harris
Emarginula, two spp.
Subemarginula occlusa, Tate
Subemarginula, n. sp.

Scaphopoda.

Dentalium mantelli, Zittel
Dentalium aratum, Tate
Dentalium lacteolum, Tate

Lamellibranchiata.

Ostrea hyotidoidea, Tate
Dimya dissimilis, Tate
Spondylus pseudoradula, McCoy
Lima bassii, T. Woods
Limatula jeffreysiana, Tate
Pecten murrayanus, Tate
Pecten foulcheri, T. Woods
Pecten consobrinus, Tate (?)
Pecten sturtianus, Tate (?)
Amussium zitteli, Hutton
Hinnites corioensis, McCoy
Crenella singularis, Tate
Septifer fenestratus, Tate
Philobrya bernardi, Tate
Plagiarca cainozoica, Tate
Barbatia celleporacea, Tate
Barbatia crustata, Tate
Barbatia simulans, Tate
Cucullaea corioensis, McCoy
Glycimeris cainozoica, T. Woods
Glycimeris laticostata, Q. and G.
Limopsis forskali, A. Adams
Limopsis morningtonensis, Pritchard
Nucula atkinsoni, Johnston
Leda apiculata, Tate
Leda vagans, Tate
Leda obolella, Tate
Trigonia semiundulata, Jenkins.
Trigonia tubulifera, Tate
Cardita delicatula, Tate
Cardita polynema, Tate
Cardita compacta, Tate
Carditella (?) sp.
Mytilicardia, two spp.
Crassatellites dennanti, Tate
Crassatellites communis, Tate
Chama lamellifera, T. Woods

Meretrix, n. sp.
Chione dimorphophylla, Tate
Chione cainozoica, T. Woods
Chione, n. sp.
Mactra howchiniana, Tate
Corbula ephamilla, Tate
Corbula pyxidata, Tate
Panopaea orbita, Hutton
Cuspidaria subrostrata, Tate
Myadora tenuilirata, Tate

Palliobranchiata.

Magellania garibaldiana, Davidson
Magellania grandis, T. Woods
Magellania insolita, Tate
Terebratulina scoulari, Tate
Terebratulina sp.
Magasella woodsiana, Tate
Magasella compta, G. B. Sow.

Echinodermata.

Clypeaster gippslandicus, McCoy
Monostychia australis, Laube
Echinolampus sp.
Eupatagus murrayensis, Laube
Astrophyton sp.
Antedon sp.

Actinozoa.

Flabellum candeanum, Edw. and H.
Flabellum duncani, T. Woods
Flabellum victoriae, Duncan
Placotrochus deltoideus, Duncan
Sphenotrochus australis, Duncan
Sphenotrochus emarciatus, Duncan
Conocyathus scrobiculatus, Dennant
Deltocyathus viola, Duncan
Trematotrochus fenestratus, T. Woods
Balanophyllia sp. (juv.)

These fossils indicate of course that Skinner's and Dreir's beds are of the type of the Muddy Creek, Murray River, Shelford, Mornington, and some other eocene deposits, and they thus come under Messrs. Hall and Pritchard's division—Balcombian.

A well was sunk for water at Little Brothers' sawmill which lies back from the river about a mile to the north of Skinner's. The surface is 146 feet above sea level and the depth of sinking 92 feet. The strata disclosed are :—

Clay - - - - - - - - -	4 feet
Drift, with occasional ironstones containing Magellania garibaldiana and other eocene fossils - - - - -	66 ,,
Calcareous sands, with numerous casts of shells	22 ,,
Total	92 feet.

At this depth brackish water was struck.

XI.—Saunders' Bluff.

That this bluff marks the last appearance of the tertiaries on the north bank of the river has already been alluded to. Farther west this bank is entirely occupied by devonian rocks and the river channel from Moitun Creek to Flaggy Creek thus outlines the boundaries of the two formations: the present stream flows now on one side of the flats and then on the other, the gorge itself being from two to three miles wide.

The river turns south east at Moitun Creek, and then, as we have seen, flows for some miles along the line of junction between unconformable strata. This would probably be the easiest course for the river to take, and its initial deflection to the east at Moitun Creek may have been thus determined.

Saunders' Bluff is 150 feet high, and up to the top of the ironstone, or for 110 feet, it stands out as a bold cliff on the river bank. The strata consist of:—

Sand - - - - - - - - -	40 feet
Fossiliferous ironstone - - - - -	20 ,,
Coloured and banded drift, and pebbles - -	84 ,,
Ferruginous soft red sandstone to river level -	6 ,,
Total	150 feet.

The height of the river above sea level is here 52.49 feet. For a drawing of the section at Saunders' Bluff see Fig. 13. The bank is too steep to be examined in full detail, but we obtained fossil casts partly from ironstone blocks now lying at the base, but fallen from above, and partly from those *in situ* near the top of the fossiliferous strata, that is, at a height of 162 feet above datum line.

Fossils from Saunders' Bluff.

Conus sp.
Turritella murrayana, Tate
Pecten foulcheri, T. Woods
Cardita polynema, Tate
Mytilicardita sp. (also at Skinner's)
Crassatellites dennanti, Tate
Meretrix eburnea, Tate
Meretrix, n. sp. (also at Skinner's)
Bryozoa spp.

XII.—Lindenow.

Just opposite Saunders' Bluff, on the south bank of the river, an interesting outcrop of ironstone occurs. Between the two

sections stretches a wide extent of the fertile Lindenow flats, bounded on the north by the Bluff, and on the south or Lindenow side by a sloping bank, which is covered by a thick alluvial deposit. The ironstone commences at about 60 feet up the bank, and is traceable along a narrow river terrace as far as Moitun Creek on the west, as well as for a long way eastward. At Lindenow the band is fairly massive, and from 15 to 20 feet thick. Owing to small quarrying operations, the face is well exposed, and though we spent only a few hours at the spot, we were able to collect many easily identifiable casts. The section was examined at an early stage of our work, and the results obtained had a large share in convincing us that the ironstone casts on the Mitchell banks from Boggy Creek westward simply represent the eocene forms, which, either in the limestones or in the shell beds at Skinner's and Dreir's, are in most cases still preserved unaltered. We have seen no clearer casts anywhere than at Lindenow, and the palaeontological evidence is thus specially decisive.

Fossils from Lindenow.

Voluta weldii, T. Woods
Siphonalia (?) sp.
Columbella (?) sp.
Murex lophoessus, Tate
Lampusia annectans, Tate
Cassis exigua, T. Woods
Potamides sp.
Turritella murrayana, Tate
Turritella tristira, Tate
Lima bassii, T. Woods
Pecten foulcheri, T. Woods
Pecten sturtianus, Tate (?)
Glycimeris laticostata, Q. and G.
Trigonia semiundulata, Jenkins.
Cardita sp.
Meretrix eburnea, Tate (?)
Chione etheridgei, Pritchard
Chione sp. (also at Skinner's)
Corbula ephamilla, Tate
Cuspidaria subrostrata, Tate
Myadora australis, Johnston
Lunulites rutella, T. Woods
Paradoxechinus novus, Laube
Placotrochus elongatus, Duncan
Placotrochus deltoideus, Duncan

On one occasion when driving along the Lindenow road we observed ironstone rocks cropping out on a grassy bank about half a mile to the south. Leaving the buggy on the road we walked over to the spot and broke up a quantity of the stone. After a prolonged search we found a few fossiliferous blocks, which shewed casts of species identical with some we have recorded from the neighbouring section.

XIII.—Summary and Conclusion.

1. The western boundary of the Gippsland miocene is extended at least as far as Bellevue and Rose Hill. Its exact limits in that direction are not determined, but farther up the river every section examined discloses only a lower tertiary fauna. The highest level at which miocene fossils are recorded in the area is at Knight's, and about 160 feet above sea level. At the mouth of Boggy Creek the river cliff is 194 feet above level, and the eocene strata are continuous up to its summit. Farther west the country still rises, and just beyond Boggy Creek reaches 230 feet, and finally at Moitun Creek 330 feet above datum line. Ironstone blocks, containing eocene fossils, were traced up to an elevation of about 160 feet in both these localities.

2. Since we dissent from Sir F. McCoy's classification of the Moitun and Boggy Creek ironstones as upper miocene or lower pliocene, we cannot accept the theory, apparently founded upon it by Mr. Howitt, viz., that the Bairnsdale limestone is denuded on its north limit and overlain by the Moitun Creek group (1). Professor McCoy determined the age of this group on palaeontological data, but the Report (1) contains no list of the species submitted to him. As a fact, a reliable classification of the Mitchell beds was scarcely possible at the date of the Report (1874). Comparatively few species were known from the Victorian tertiaries generally, while the molluscan bed at the base of the Skinner's section was then practically unworked. The latter of course supplies the key for the interpretation of the Moitun and Boggy Creek casts.

Again, from Lindenow up to Moitun Creek, the Bairnsdale limestone is entirely wanting, and the river banks show instead, on the south, ferruginous sands resting directly upon devonian strata, and on the north, the latter rocks only.

From Bellevue eastward there is, on the contrary, evidence of the erosion of the limestone before the deposition upon it of the so-called upper pliocene (really miocene) beds, and to this extent we are in accord with Mr. Howitt.

The following table shews the classification of the Mitchell tertiaries as given in the Reports (1 and 2), and by ourselves in the present paper.

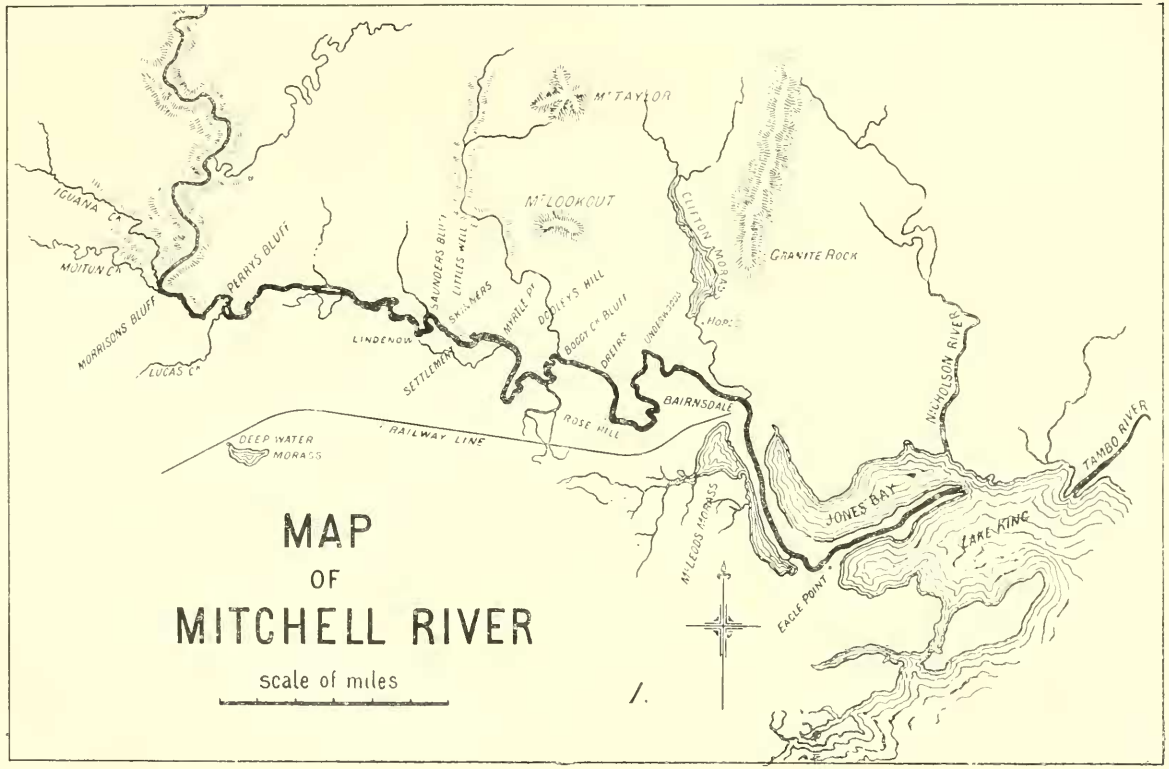
	McCoy.	Howitt.	Dennant and Clark.
Jemmy's Point	Pliocene	Upper Pliocene	Miocene
Bellevue and Rose Hill	———	———	
Moitun Creek and Boggy Creek	Upper Miocene or Lower Pliocene	Lower Pliocene	Eocene
Bairnsdale limestone	Middle Miocene	Middle Miocene	
Skinner's and Dreir's	———		

3. The Mitchell River gorge from Moitun Creek downwards has, no doubt, been carved out in post-miocene times, and the drifts and coarse gravels of the terraces, as well as of the country bordering them, have been mainly transported by streams from the northern hills or by the river itself.

4. On the final elevation of the land at the close of the miocene period, the difference in level between Moitun Creek and the sea does not appear to have been much greater than at present, otherwise the river would have cut a far deeper channel than it has. Say the difference was 150 feet greater, then in such soft material we should expect a wide and deep channel to be cut, which afterwards would be filled up with sediments when the land subsided. There is no evidence of this. At East Bairnsdale, borings have been carried to a depth of 250 feet, or from 180 feet to 200 feet below sea level. Now, at a depth of 150 feet, or not more than 50 feet below sea level, eocene shells were struck. These included Clypeaster gippslandicus, a common form in the Bairnsdale limestone.

Further, the Nicholson and Tambo rivers, which, even now in places, as at Swan Reach, flow between eocene and miocene cliffs, have certainly no deep recent beds beneath them, such as they should have if the country had once been 150 to 200 feet higher and then had subsided to its present level.

The local evidence is thus opposed to the theory of a former superior elevation of the land, except of course by the amount due to ordinary subaërial denudation.



Proc. R.S. Victoria, 1903. Plate II.